

Accelerator Systems Division Highlights Ending October 24, 2003

ASD/LANL: Warm Linac

HIGH-POWER RF (WBS 1.4.1.1)

Accomplishments This Week: (1) All 1st articles for the 5-MW RF system for the CCL have completed acceptance tests! A 5-MW circulator passed and a 5-MW load each passed their acceptance tests at LANL for the first time. (2) We are in the processes of installing the second 5-MW circulator, and have He leak checked it with the three Kapton windows. (3) J. Bradley visited ORNL this week to review the SCL RF transmitter startup and installation checklist prepared with M. McCarthy. He also inspected status of installation of the first SC transmitter, and assisted in installing PLC software and in checkout of EPICS communication. LANL staff will return to ORNL when SCL RF system commissioning begins on 11/17. (4) T. Hardek is at Thales to witness the factory acceptance test of 550-kW, SCL klystron S/N 7. He reviewed their test stand calibrations. Thales finished the 24-hour heat run. The remaining acceptance tests are in progress.

Concerns & Actions: (1) While the recent performance of the Thales 5-MW klystron has significantly improved, we remain focused on delivery schedule of the remaining 7 tubes. A meeting is scheduled next week to work with Thales senior management to negotiate a conditional acceptance of the first 5 MW tube. D. Rees, D. Mack, and D. Rej will represent LANL. Also, T. Hardek is at Thales for a factory acceptance test. The start of the acceptance tests was delayed from 10/21 until 10/24 because Thales is having problems getting the AFT window to pass the He leak test. Hardek has extended his trip to 10/28. (2) While we were able to pass a 5-MW CCL load for the first time, we remain concerned about the ability of the other articles to pass. A factory engineering rep came to LANL this week to address the first load failure. He believes the failure was due to a tolerance build up on the flanges and asked that we face the flanges off. At the present time the flanges are at the machine shop. There is another potential problem related to the warranty service for these loads. Our contract is with Sure Beam, but Sure Beam recently sold the load business segment to a small company. Consequently it is likely that if a major design defect is uncovered in testing we may need to assume the full responsibility for the repair and involve the legal department to try to recover warranty costs from Sure Beam.

HIGH-VOLTAGE POWER CONDITIONING (WBS 1.4.1.2)

Accomplishments: (1) W. Reass and J. Bradley were at ORNL to assist D. Anderson and C. Ziomek in tests of pulse width control on a production HVCM. Tests were unsuccessful. While CD-4 performance can be achieved without this control, all parties will continue to work to enable this option. (2) We continued the design work for the filter chokes to reduce the high frequency ripple in HVCM output. (3) The prototype HVCM system operated well in supporting the full power tests of 5-MW circulators and loads.

Concerns & Actions: The LANL production HVCM is down because of a SCR controller. The output voltage suddenly jumps which overcurrents the SCRs and trips the system. There are several possible causes and we have requested Dynapower support. New circuit cards are on the way to try to fix the problem. If this doesn't work we will request site support.

DRIFT-TUBE LINAC (WBS 1.4.2)

Accomplishments - Tank-2: All drift tubes were scribed for cosmetic e-beam weld repairs. Cosmetic weld repair procedure was developed and implemented. Four of the four known leaking units repaired. No severe eruptions were observed during the weld. Units were leak tight in a He spray test at ESCO. Cosmetic weld profiles are very good thus far: 0.003" max deep edge crater with smooth broad bottom. The pressurized He leak checking unit at ESCO failed so we are doing pressurized leak checking at LANL. We have elected to proceed with repairs even though we will not have pressurized leak test confirmation until late 10/24. We discovered a machining non-conformance on unit 2-7 (~0.002" short on length). This prompted a record check for the balance of the tank; no additional non-conformances were found. Physics team personnel were consulted and they found this non-conformance to be tolerable. One cap weld (on unit 2-1) was given a cosmetic weld repair in error; we are having an inspection performed to determine change in profile. If required, plating repairs will be performed to restore profiles. All of the J's should be repaired by COB 10/24. Balance of tank two units should be repaired by end of next week

Tank-5: First batch of drift tubes are at LANL for final processing with final batch arriving on Saturday. Units were "bumped" at the plating vendor by the SNS EMD drift tubes. We are still looking for two top hats; CMI has three complete production spare top hats and if we do not locate the missing units we will purchase two of the production spares. We will work Saturday, 10/25 to address the developing backlog of final processing work.

Tank 6: All units have the stems welded on including the rebuilt unit 6-17. These units are currently undergoing stem straightening and will all go to the plating vendor on 10/27.

EMD and BPM DT's: Rapid progress is being made on these units. Ten EMD DT units (3-26, 3-29, 4-18, 4-21, 4-24, 4-27, 5-13, 5-22, 6-12 and 6-18) are plated and ready for final processing. Six of these (three from tank four and three from tank six) are at the final processing facility. We will do a trial "bake" of an EMD magnet and if the results are satisfactory we will begin the final processing of these six units on Saturday, 10/25. Four EMD DT units (1-49, 2-39, 2-45 and 3-32) are waiting for plating. Final machining is in process on the remaining ten EMD DT units (1-52, 1-55, 1-58, 2-36, 2-42, 3-23, 5-16, 5-19, 6-15, and 6-21). Tank two and three BPM DT's are mapped and are in final inspection; one of the tank four units and the tank five and six units are in mapping. The repair of unit 4-3 at Sciaky is complete and was successful (Fig. 1). If a priority decision must be made we are producing EMD and BPM units in this tank order: 4, 5, 6, 3, 2 and 1. If a unit is ready to proceed it will not be held back to abide by production order. After comment from ORNL this priority has been changed to 1, 4, 5, 6, 3, and 2 although given the status of the drift tubes any priority change now will have reduced effect on delivery dates.

Beam Boxes/Grilles, Pump Ports, and Slug Tuners: Nov. 7th is now current earliest estimated delivery date from Integrated Machine for beam boxes 1/2 and 2/3; we will ship to ORNL approximately a week later depending upon drift tube final processing work load and machining. Pump grills and cover plates with the exception of one unit scrapped due to a tool crash will be complete tomorrow. Replacement for scrapped unit being made from spare parts and stock; expect delivery late next week.

Issues and Concerns: (1) Tank-2 leak repair is ongoing, but final results are not certain. (2) Personnel are returning from vacation and some have been extended so staffing will stabilize for several more weeks. (3) Large number of drift tubes are now being processed at LANL; we are concern about quality assurance and handling accidents. (4) The issue of moving slug tuning work to ORNL needs to be resolved; it likely will require a contract modification.

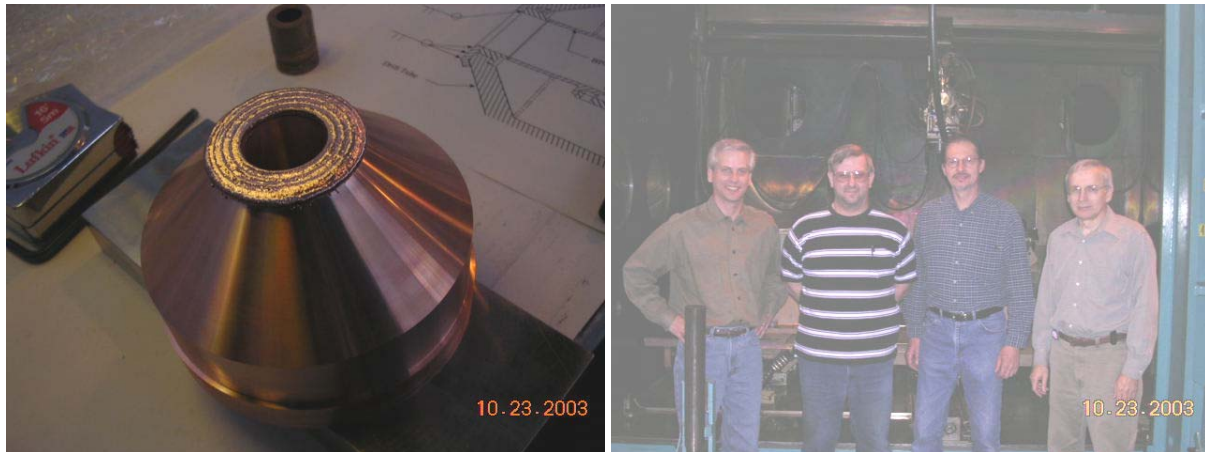


Fig. 1: E-beam welding activities at Sciaky were completed with the repair of BPM drift tube 4-3. Shown in photo is a sample drift tube after qualifying the ring washer repair and the Sciaky-LANL team after completion of that last drift tube weld.

COUPLED CAVITY LINAC (WBS 1.4.4)

Accomplishments: (1) Module-1 (Fig. 2) tuning was successfully tuned to within range. Fields and tilt sensitivity are acceptable. We anticipate a final tuning pass will be necessary in the SNS tunnel after the modulator is disassembled, packaged, shipped, and reassembled at ORNL. Congratulations to ACCEL staff and to J. Billen, N. Bultman, C. Diebele, and J. Stovall who spent long hours at ACCEL over the last three weeks. (2) ACCEL brazed three CCL segments for Module-2. This represents a record production rate for this order.

Concerns & Actions: While progress on Module-2 manufacturing is encouraging, we remain concerned about sustaining this performance over months. We continue to be in daily contact with ACCEL, and receive weekly milestone and schedule updates from their management.



Fig. 2: CCL Module-1 tuning and sizing of the RF feed iris.

ASD/JLAB: Cold Linac

Testing of the M-5 cryomodule has resumed. Marginal but acceptable performance of cavity #3 has been confirmed (vacuum excursions), but there has been some improvement during operation, so there is reason to expect this cavity to meet specification at some future date, if time can be found to run it. Waveguide connections have been transferred to cavity #2.

Two of three cavities processed and installed in dewars before, but not tested until after the hurricane, have passed qualification tests. Both are high- β cavities. Cavity MB-26 has been processed with a modified set of procedures that implement some of the recommendations of the SNS Review Committee. It is through chemistry and high pressure rinse, and is being evacuated in the clean room in preparation for mounting on a test stand.

Modifications to the chemistry cabinet to provide an engineered barrier to the sort of acid exposure reported last week are complete. Chemistry operations resumed with completion of the SOP modification.

Assembly of the M-7 cryomodule is continues.

ASD/BNL: Ring

Preparations continue for the upcoming DOE Review and dry run.

The first RF cavity and ancillary equipment were delivered to SNS/OR.

Momentum Collimator – AP has confirmed the final lattice placement. Installation drawings are being circulated for Engineering and AP sign-off.

Extraction Kicker PFN – our EE Group reported that the extraction PFN, being built by APS in Hicksville, LI, was successfully tested to 35KV in air with a load current of 2.5 kA. The waveform looks good; the rise time is less than 200ns.

G. Murdoch, M. Hechler, T. Hunter and M. Holding were at BNL this week to review Project status and outline our mutual objectives, milestones and goals for the next six months. A report summary outlining the salient issues is being prepared.

The support bases for the HEBT in-line collimators are completely assembled and painted. Preparations are being made by BNL personnel to ship the assemblies to SNS/OR in time for the DOE Review.

Two RF junction boxes (and cabinets) are finished and are being prepared for shipment to SNS/OR.

Vendor bids for outer shielding for the Ring collimators (#2 & #3) have been reviewed for acceptance. Our plan is to procure the permanent shielding now (FY04) and the removable shielding later (FY05). A contract is being prepared for the low bidder.

Tesla reportedly has shipped eight (8) 21Q40 magnets and 9 stands to SNS/OR. ETA is Nov. 14.

Oak Ridge Tool and Engineering completed a "trial" stacking of the momentum collimator outer shielding. Delivery to SNS/OR is scheduled for Nov. 4th.



Photo #1 (0382) shows our first ring doublet assembly.

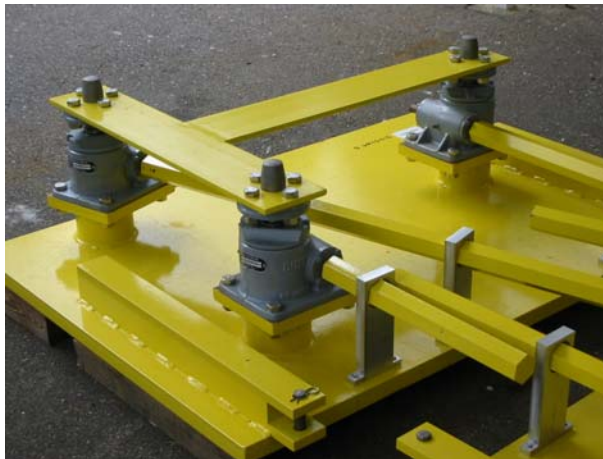


Photo #2 (0373) shows one of two bases for the HEBT.



Photo #3 (0366) shows our first trial assembly of a quarter-cell.

Controls

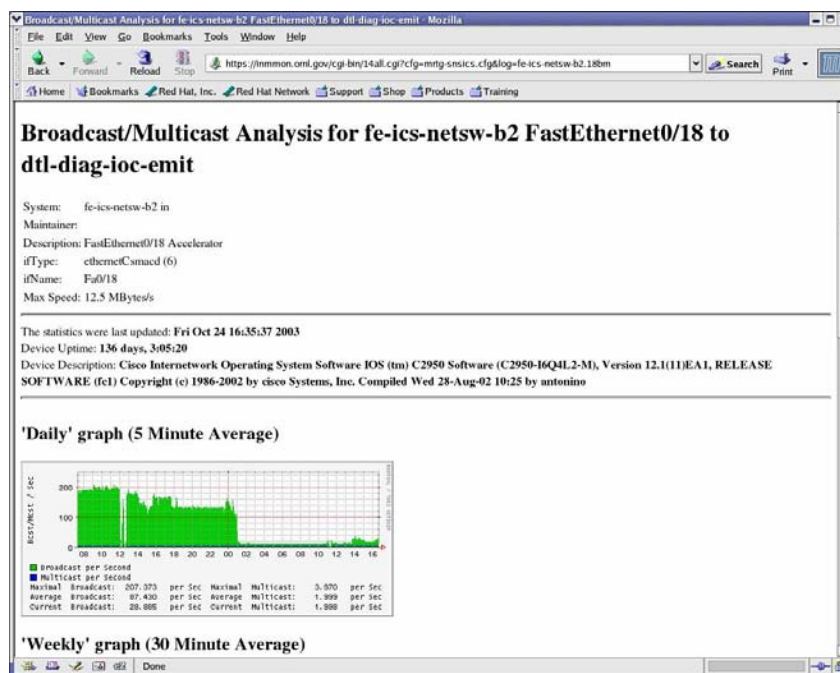
Calibration of most of the control system sensors for one of the CHL first stage main compressor skids was completed. The water flow sensor and slide valve position indicator cannot be calibrated until water is flowing and the oil pump is running. This work is taking longer than expected. Most of the temperature and pressure shutdown switches were not wired in the correct 'fail-safe' manner. Also, several of the temperature and pressure sensors were not installed properly by the vendor, PHPK. These sensors must be removed from their wells in order to perform the calibration. Several of the temperature wells have broken loose while attempting to remove the sensor from the well. The wells were glued in with epoxy. The picture below is not staged. These are the tools needed to remove the sensors from the wells. This is not quite the delicate instrument work we expected. So far, two of the sensors have been destroyed during the removal process. And, as you would expect, the vendor used non-stock sensor elements. Delivery of the replacements is at least 4 weeks.



EPICS version 3.14 is now running on the Front End Hot Spare. The timing system will be installed next week.

At the EPICS Collaboration and ICALEPCS Meetings held in Korea last week, the Accelerator Controls Community spent some time discussing the IOC communication problems we have been experiencing here at SNS – what has become known here as “IOC Disease.” Several Laboratories had experienced similar (but not identical) symptoms at various times, and we were supplied with many suggestions. The follow-up this week was a series of meetings and phone conferences at which specific tests and actions were planned and results reported. The result by the end of the week was the identification of a subtle software misconfiguration of the basic IOC software which

resulted in the “broadcast storms” that we had already identified as a major contributor to our observed symptoms. A brand new tool – introduced with the latest version of EPICS – allowed us to identify the problem. When corrected, the level of broadcast traffic was reduced significantly, and many negative symptoms disappeared. (Note the drop in the chart below.) Of particular note – the RF Reference Line controller, which is a commercial product with hidden proprietary software, apparently had been unable to handle the broadcast traffic. As soon as this traffic was reduced, it started behaving correctly. There are clearly remaining issues, and some symptoms that have not been fully understood, but this IOC reconfiguration appears to have addressed the major source of problems. We’ll keep at it and keep our fingers crossed. Thanks to all of our international partners for their interest and ideas.



The SCL RF transmitter controls have been checked out for SCL1. The HV Modulator is virtually the same as for the warm linac. The tuning rack controls have been tested for SCL1 which are as ready as possible for high power.

The Residual Gas Analyzer driver is installed and released. This version does not compensate for base pressures - that will be done in a subsequent release. The CCL1 wire lists have been reviewed for vacuum and RCCS.

Further characterization of the Resonant Cooling Control System (RCCS) was done in preparation for a follow up meeting to the earlier workshop on this topic. A mode was added to allow the operator to put the loop into an “average resonance error” mode.

Installation

Craft Snapshot 10/21/03

ASD craft workers	53.0
Formen, ES&H, etc.	9.0
Less WBS 1.9 etc	9.0
Less absent	3.0
TOTAL	50.0

DTL #2 drift tube cosmetic weld repairs appear to be successful. All DTL #2 drift tubes are scheduled to be delivered by the end of Nov. This results in a DTL #2 installation date of 09JAN04.

SCL HVCM ME 01 will be installed and tested by the end of next week.

The first six 550 KW klystrons supported by SCL HVCM ME 01 will be operational by 17NOV03. LANL will be at SNS to perform their lead role for these systems.

With CCL #1 tuning to be completed next week, the shipment of the first unit from AXEL is scheduled for mid Nov, 03.

The first accepted 5 MW klystron, load and circulator for CCL #1 rf system is schedule to be shipped 17NOV03.

125 feet of piping for the laser wire system has been installed. Vibration measurements will are being taken and will continue next Week.

The 12th half cell from BNL will be received next week.

The HEBT gantry crane will be installed by Blain next week.

RFQ

After final tweaking of the resonance frequency the adjustable tuners were extracted from the RFQ, measured and actual sizes sent to the machine shop. Adjustable tuners wee then reinstalled to allow work on the RF power splitter.

We found that after the RFQ retuning power splitter is severely misbalanced and requires retuning. We know from Berkeley experience that tuning it by rotating the driving loops is extremely difficult and time consuming procedure. Therefore we came up with idea to use tuning screws in the coaxial elbows on the air side of the RF windows. After successful test of the idea on one elbow, Rob Morton installed pair of screws on each of 8 elbows and we were able to achieve acceptable balance without touching the RF loops and breaking vacuum seal. Electrical strength of the gap between the screw tip and the central conductor of the coaxial line is still a concern, therefore Yoon ordered some "button head" screws, which we believe can hold required RF voltage in the coaxial line.

Machining of the fixed tuners of required length have been finished on Friday and we'll receive and install them on Monday. Rob Morton has started to close and vacuum seal the end-wall of the RFQ and other penetrations in order to start vacuum check out as soon as we get the fixed tuners installed.

Accelerator Physics

D. Jeon is analyzing DTL emittance scan results and comparing with simulation. Measurements show small emittance tails, similar to those observed in the front-end commissioning. This halo can be mitigated with the addition of scrapers in the front-end, and a modification to the MEBT optics.

S. Cousineau has implemented chromaticity adjustment knobs into the Ring Optics Tuning Program.

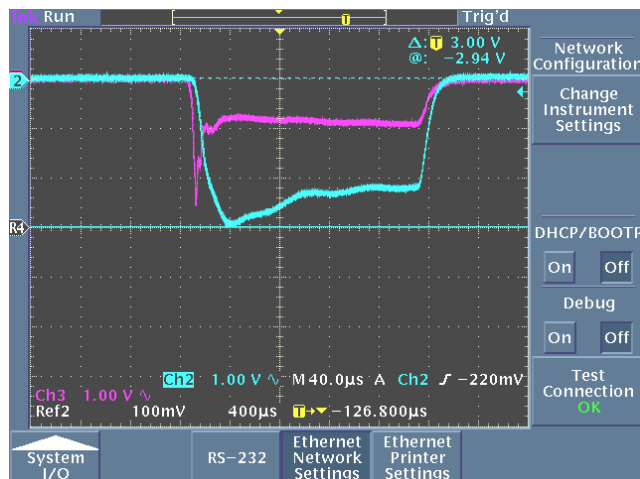
V. Danilov has written software to perform the emittance & Twiss parameter estimation from beam profile measurements in the transport lines.

The work of a summer student, Steven Bunch, was selected for publication in the DOE's Journal of Undergraduate Research. Steve's paper reports on a study of closed-orbit errors and losses in the SNS ring using the ORBIT code.

Operations Group

Ion Source Group

On October 21, 2003, after a successful cesiation, the ion source on the hot spare stand delivered a peak current of 60 mA H⁺. The beam current can be seen on the oscilloscope as a blue trace while the purple trace represents the electron current on the extractor, with both currents being measured with 50Ω resistors.



The 60 mA beam current was the start of a successful ion source lifetime test during which the ion source was kept in continuous operation for over three days, only occasionally being retuned and re-cesiating to maintain a current output above 40 mA. After the initial 24 hours with 10 Hz 200µs pulses, the pulse length was increased to 1 ms, and after another 24 hours the rep rate was increased to 30 Hz, and finally, after another 24 hours the rep rate was increased to 60Hz to operate at the full nominal duty cycle. The life time test had to be terminated to assure the completion of the spare LEBT installation by the start of the DOE review.

On Monday we walked Lloyd Gordon from LANL through our Big Blue Box high voltage safety system and procedures. As a rather strange coincidence, this was the first time that we observed the grounding relay of the 65 kV platform to remain open despite having been “lowered”, having the safety chain disabled, and having the access doors opened. It was found that the HV grounding relay continued to be powered from a lower level relay that hung up. After being cycled, the system resumed normal operations. While that raises concerns, safety remained guaranteed by three complementary safety measures.

Lloyd praised several of the safety features that were recently implemented. He agreed with us that the system is safe and we agreed with him that the safety could be improved. We plan to collaborate with him to add another safety layer to the system, likely involving an additional, fully independent grounding system and captured keys.

Many of us attended Lloyd’s safety seminars on electrical, RF, and other hazards, which were very informative and well presented.

Survey and Alignment

This week the Survey and Alignment group resurveyed the internal flanges of Medium Beta Cryomodule 03. We performed a survey of MB03 back in June 2003 at JLAB. This resurvey was a check to determine if there was movement internally due to transportation. We did find movement both in the vertical and the horizontal on all but two of the flanges.

This week, we made a trip to Oak Ridge Tool to survey the lower section of the momentum collimator plates. This survey was to determine the flatness of the top plate and to obtain a dimensional measurement from the base plate to this top plate. Since the unit was not built with gravity in mind, we will have to rotate the measurements to a gravity reference plane before we can analyze the data.

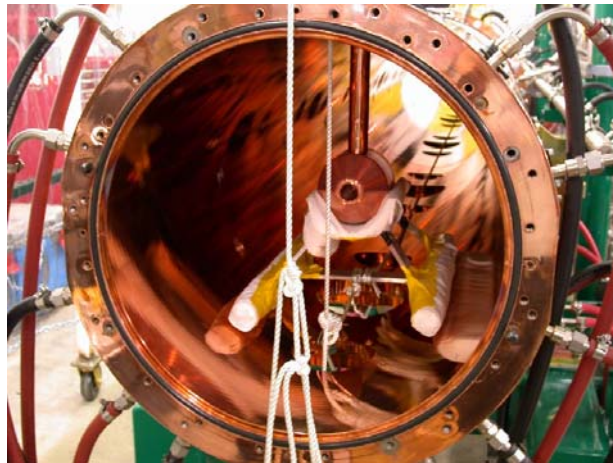
Completed layout of the Momentum Collimator base bolts however this layout will probably change based on new information coming from BNL.

The Survey and Alignment group is performing an intense leveling campaign through our monuments along the length of the LINAC. This is a well needed campaign now that backfill has been completed and time has elapsed for allowance of recompression settlement.

We are continuing the fiducialization of drift tubes for DTL4. All DT_Tank-4 Drift Tube Magnets presently here have been completed.

Mechanical Group

All 21 of the DTL-4 PMQ and empty DT's have been fiducialized, leak tested, and magnetically mapped. DT 4-2 was installed in the DTL-4 tank to test our handling procedure for these large DT's which weight about 23 pounds each. No significant problems were encountered during installation.



DT 4-2 Installed in the Tank

Nickel plating of the o-ring grooves in the ends of the DTL-5 tank sections is in progress. This plating is for corrosion protection of the bare grooves in the carbon steel tanks. Assembly of the tank sections is planned for next week.

Water Systems Installation

- Installation of SCL ME-01 piping was completed with pressure and leak testing completed. The entire system is now ready for operation.
- Preparation for installation of SCL ME-02 piping was started.
- Installation of the CCL-2 HVCN and SCR-cabinet piping was completed.
- Preparation for installation of the CCL-3 HVCN and SCR-

Ring Systems Installation

- Installation of the HEBT truck entrance 20 ton hoist was started.
- Preparation for the HEBT in-beam and momentum collimator installations continues.
- A visit was made to the HEBT momentum collimator shielding fabricator to examine the preliminary shielding plate stack-up.
- The first RING RF Cavity assembly was received and staged over in the RF Test Facility.
- A visit was made to BNL for an installation schedule and component status review. Minutes of the meeting will be published within the near future.

Magnet Task

We have completed measurements of DTL Tank 4 PMQ drift tubes. The enclose chart shows results of LANL measurements, ORNL measurements and vendor measurements.

We are progressing on 21Q40 measurements in that Joe Error's group has made an alignment for us. We also measured another CCL quad this week.

Electrical Group

We continued to checkout the SCL-ME1 modulator, and anticipate completion by month's end.

Testing occurred on DTL-ME3 this week with LANL and Ztec participation, attempting to characterize the pulse width control margins on the IGBT drive signals which result in acceptable switching losses. Initially, while trying to reset the DSP in the control chassis, we discovered a bug in the software which "freezes" the gate drive signal at the time of reset, resulting in saturation of the transformer and destruction of the IGBT(s). Ztec will upgrade the FPGA to address this problem. After this was repaired, we attempted to reduce the conduction angle of the IGBTs by 1 us (out of 23.5 us), resulting in destruction of the IGBTs due to voltage oscillations and significantly increased switching losses. We will, at some point in the future, have to investigate alternative Pulse Width Modulation schemes to reduce pulse droop and asymmetrical gate drive techniques.

DTL-ME1 experienced a failure in the SCR cabinet, likely due to problems with the gate drive electronics. Four out of the six SCRs in the bridge shorted, resulting in phase-to-phase shorts on the AC input. This destroyed a fuse in the switchgear. After the bridge was rebuilt, the fuse replaced, and two gate drive PCBs replaced, we were able to get the SCR controller running. We suspect design problems related to those experienced at LANL (which don't appear to be evident until significant hours are accumulated on the units) and will press this matter with Dynapower.

HPRF

Moved six 805 MHz 550 kW klystrons to the MB-3 & 4 HV tanks in the gallery. These are the second half of the MB_SCL_ME-1 system. The water systems for all twelve klystrons have been piped in. The cable pulls for the MB-1 & 2 transmitters are 75% complete.

Picked and placed 12 klystrons from tanks in the RFTF to four free standing SCL HV tanks in the Klystron Gallery freeing up in the RFTF for test and development work and LLRF chassis production. The klystrons are staged for installation of the next two SCL transmitters.

Completed 402.5 MHz 2.5 MW klystron forward power calibration of all DTL RF systems. Brought the DTL2 klystron up to full power running into a shorted waveguide. The RFQ, DTL1 and DTL2 RF stations are all connected to the ME1 and operational. DTL3 is operational on ME2.

Attempted to bring the DTL4 (ME2) klystron up to full power. Discovered arcing at the waveguide output as power exceeded 1.5 MW. Found the output transition was cracked. The inner conductor appears longer than the outer conductor putting stress on the disk that connects the two. Inspected DTL 5 & 6 (ME3) RF stations and found both were somewhat stressed for the same reason. This problem is similar to what ailed DTL 1 & 2 klystrons, and were subsequently repaired. The klystron vendor (E2V) is sending a rep to investigate and make repairs next week.

LLRF

The Third Generation Field Control Module (FCM) was installed and tested in DTL1. Improvements to the EPICS sequencer are ongoing. Operation of the 800 us feedforward buffer was confirmed; the implementation of the 1300 us buffer is in progress. There is a problem, evidenced by noise spikes in the waveforms, with DMA data transfers between the FCM and the IOC. This problem is only seen when the FCM is installed in the klystron gallery; it has not been observed in the lab. It is not dependent on HVCM operation. The problem can be circumvented in the short term by simply turning off DMA and accepting the larger workload for the IOC. The problem is under investigation.

The FCM FPGA boots via PROM upon power on and can be booted via the VXI backplane, depending on software configuration, upon IOC reboot. Both methods were demonstrated this week on DTL1.

The procurement of electronic components for the FCM and High Power Protect Module (HPM) production is in progress. Parts have begun to arrive.

The communication problem between the reference line IOC and the reference line temperature regulation system has been repaired through a joint effort of LLRF and Controls personnel.

The 2nd quote for the 805 MHz reference line was received on Friday. We plan to place an order for this line in November after reviewing the quotes and resolving any open issues.

Kay Kasemir of LANL visited ORNL and assisted with FCM and High Power-Protect Module (HPM) EPICS issues.

Hengjie Ma attended a week-long FPGA design course. Mark Crofford attended electrical safety courses Tuesday-Thursday; he is the electrical safety officer for the RF Group. Several ORNL team members attended pulsed power and RF safety training on Thursday.

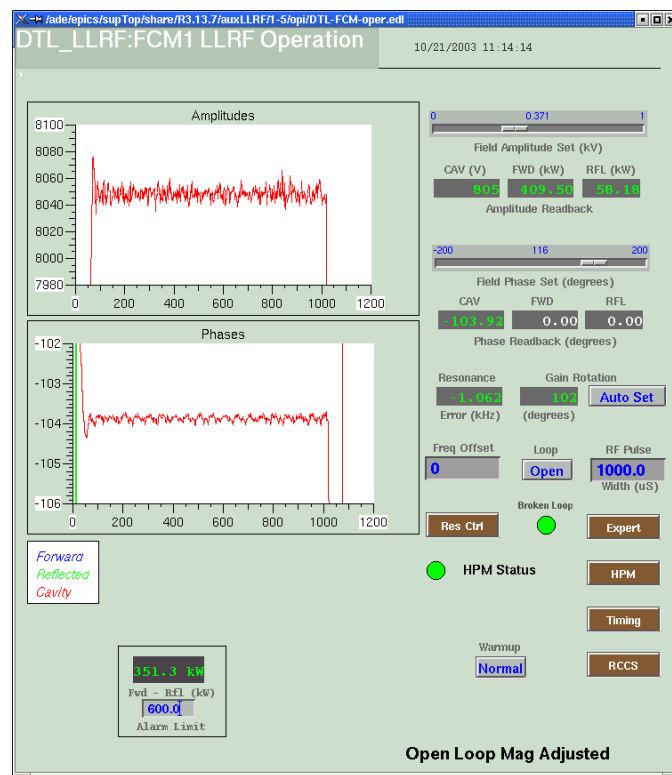


Figure 1. Snapshot of EPICS sequencer for DTL1 under closed-loop feedback control (never mind the “open” loop descriptors). Regulation of approximately $\pm 0.2\%$ and ± 0.2 deg was achieved.

Cryosystem Group

Work continues on preparing the warm compressor skids to receive the PHPK processed oil. We have cleaned out the oil filters and selector valves on the skids; they contained some oil residue from the filter elements. The booster oil pump has arrived and is being fitted to the extraction pipe for the oil barrels. We will start the purifier next week and circulate purified helium through the warm compressor skids.

Beam Diagnostics